On Track

The Newsletter of the International Fission-Track Community

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In this Issue:

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Editor's Notes

Issue 16 of On Track marks the 8th year of the newsletter's existence. This in itself is a testament to its worthiness to all of us "Trackers." Since issue #15 was released six months ago, I've received over 60 emails or letters from different folks and groups. The majority of these letters have included requests for information on others, new additions to the growing FT directory, or simply supplying updated information on themselves for the directory. Furthermore, a small number of these contacts have included reports on new ideas, most of which have been reproduced herein. Therefore, it seems that On Track continues to serve members of the international FT community in the form it was originally conceived - by bringing important issues and information to the attention of Trackers wherever they might be.

In this issue of On Track, **Tracker** presents some novel ideas on the controversial measurement of zeta, and finally comes out and tells us how much a *Tony* and a *Nancy* are really worth. In addition, **Hisatoshi Ito** has kindly provided some new suggestions concerning an improved method of mounting apatite grains for fission track analysis, while **Ewald Hejl** introduces to many of us a new method by which decent mineral separations may be achieved. This issue also contains many other features including a short article by **Mel Mitchell** (shortened from Melinda) in which she offers her view on presentation of "FT ages," as well as an updated version of the fission-track directory - taking into consideration the changes offered up over the last six months, and an assortment of *short track news*.

I'd like to now introduce the next Editor of On Track, **Alexander "Sandy" Grist**, from Dalhousie University. Sandy received his M.Sc. degree from Dalhousie University in 1989, doing a study of the provenance and thermal history of detrital sandstones of the Scotian Basin, offshore Nova Scotia, using the apatite fission track and $^{40}Ar/^{39}Ar$ methods. Since his graduation he has been a Researcher and the Technical Manager responsible for day-to-day lab operations of the Fission Track Laboratory at Dalhousie University (address in the FT community directory).

In the past few years Sandy has been revising and expanding the database for the Atlantic margin of Canada (currently a 'hot' area for Canadian oil and gas exploration) including uplift of the Humber Zone of Western Newfoundland and the Carboniferous/Permian Maritimes Basin beneath the Gulf of St. Lawrence, studying various models for post-Acadian tectonism. He is also studying the Hibernia and Terra Nova Basins, offshore Newfoundland (which are setting records for Canadian oil production) and the Sable Basin

offshore Nova Scotia, (currently undergoing a multi-billion dollar gas pipeline development) to develop subsidence models for the rifted margin in these areas. In the Labrador margin he is attempting to test tectonic models for Atlantic rifting. Sandy intends to eventually produce his PhD thesis from this work.

Other projects that Sandy is involved with include the paleotemperature history of the Western Canadian Sedimentary Basin and Peace River Arch regions (with D. Issler, S. Willett, C. Beaumont, R. Donelick, and C. Ravenhurst), Cenozoic tectonics of the Eurekan orogeny in Ellesmere Island (with D. Arne, M. Zentilli, A. Embry, and M. Collins), thermal history of the western part of the Variscan fold-and-thrust belt (with U. Glasmacher and M. Zentilli), uplift studies of the Coast Ranges of the Canadian Rockies in Western British Columbia and Vancouver Island (with L. Currie, R. Parrish, and M. Zentilli), and the Andes through the Multinational Andean Project (MAP) (with numerous scientists from the government surveys of Argentina (SEGEMAR), Bolivia (SERGEOMIN), Chile (SERNAGEOMIN), Peru (INGEMET), and Canada (GSC)), thermal maturation of the Neuquen Basin, Argentina (with N. Munoz), and others.

Now, as my last acts as Editor I must say that I have thoroughly enjoyed organizing the last two issues of On Track. I must also give special thanks to the many contributions world-wide who made it easy to pull issues together, and to **Andrea O'Sullivan** who helped organize the final distribution of issues- hey, labeling and sealing over 150 envelopes for mailing is not a great deal of fun. Finally, I would also like to thank **Mike Krochmal** of Autoscan Systems, **Ray Donelick** of Donelick Analytical Inc., and **Trevor Dumitru** of FT Stage Systems, for ordering advertisements, which have permitted the continued free distribution of On Track.

POS

How Many Greens In A Tony?

by Tracker

(Your man at the microscope, with the Hercynian granitoid and the natural glasses)

"What are the units of zeta?" Not a question that one expects to be asked in polite company, or indeed anywhere. We were revising our book chapter in response to an impressively meticulous analysis from our editor. A peaceful activity in which I would read aloud, first our offending sentence, then the editor's suggested alternative and then, occasionally, an essay by the editor's friend. My co-author would idly tap his keyboard in consideration, possibly changing a hyphen here or a comma there, before moving to the next sentence. Occasionally, with a gasp of satisfaction, he would find another log and change it to ln.

Oxford blues

Commas were, in fact, of some concern. It was clear that our editor had no time for that noble literary construction the Oxford comma, for they had been ruthlessly blue-penciled, except for a few late ones that we put down to luck and one that was, unaccountably, inserted. Here is an example:

"… this would normally involve using suitable graphical displays, numerical summaries and diagnostics, and the fitting of models that reflect the geological environment."

The Oxford comma is the one before the "and". Of course we are taught that a comma should not precede an and or an or. But in this case it does serve a purpose of separating the first three activities, to which the adjective "suitable" applies, from the other activity (the fitting of models) to which the verb "involve" applies. Without it, the meaning is less clear and the grammar dubious. You may well say why not write something more interesting, but that is not the point.

An Oxford comma, incidentally, should not be confused with an Oxford *Street* comma, which would come between Dickens and Jones and Marks and Spencer and Waring and Gillow. Alas these last names are nowadays rarely heard in Oxford Street, of whom the late Sir Maurice Kendall memorably recalled:

Waring and Gillow, slept on one pillow,
Not for economy, but for reasons of bonhomie.

Sir Maurice's speech was on the importance of being a pair — and on the relative importance of choosing a partner whose name starts later in the alphabet. Other examples included Neyman and Pearson, Durbin and Watson, Box and Cox, and of course Kendall and Stuart. Waring and Gillow were the exception, which may also explain their demise. But while becoming a double act was a sound recipe for success, MGK (as he was known) warned us against

collaborations of more than two, unless you came first, for fear of vanishing into *et al.* He would therefore be astonished to learn that the latest edition of Kendall and Stuart's *Advanced Theory of Statistics* is called *Kendall's Theory of Statistics* by Stuart and Ord.

Chicago style

Our editor, presumably out of fairness of mind, had in addition inserted a number of what can only be described as Chicago commas, such as:

"In statistical science, it is standard practice to use …" ,
"For some data sets, it is not obvious whether …", and
"With the external detector method, we could in principle …",

so that the overall comma density, ρ_c, was practically unchanged. However, the main rule of Chicago English is that "however" is invariably replaced by "but", which is undoubtedly a good thing.

Prepositions were another contentious matter. A preposition, so the saying goes, is something you should never end a sentence with. But it is impossible to explain naturally the meaning of a confidence interval *without* ending with a preposition — it is the range of values of the parameter that the data are consistent with. My teacher, who was not acquainted with the finer concepts of statistical inference, would say that ending a sentence with a preposition was something up with which he would not put, thereby avoiding a double-prep ending. This must be an extreme position, otherwise why would Shakespeare have written

"My pulse as yours doth temperately keep time,
And makes as healthful music — it is not madness
That I have uttered, bring me to the test
And I the matter will re-word, which madness
Would gambol from." ?

In fact it is possible to end with *more* than two prepositions. I believe the record is five, held by the child who said "What did you bring that book I didn't want to be read to out of up for?"

A basic unit

Our editor's question came as a shock for another reason, for we had just been pondering a more basic question: "What are the units of *track density*?". Tracks per square centimeter, you will no doubt say, writing it as t/cm^2 . Of course "tracks" is short for "number of tracks" and is not really part of the *units*, so the official symbol would be cm^{-2}. But no one *thinks* of tracks per square cm, as shown by the following typical conversation in the lab:

KERRY: Those zircons from China are too dense to count.
CHERRY: We must have over-dosed them.
What was row dee?
KERRY: One point three.

(For Kerry/Cherry substitute Hari/Shari, Andy/Sandy, Danni/Yanni, Barry/Thierry or Casey/Tracy as necessary.) Kerry says "One point three" while looking at some computer output displaying the number 0.13287936E+07, which would no doubt later translate into $1.33 \times 10^6\ cm^{-2}$ in a report. Our editor had also doggedly inserted " $\times 10^6$ " wherever we gave a numerical track density. But Kerry does *not* say "One point three times ten to the six". The natural *unit* of track density is surely *millions* of tracks per square cm, that is, $10^6\ cm^{-2}$, rather than cm^{-2}. This unit needs a name: I propose ***Nancy***, with international symbol **Ny**. The above density would then be 1.33 Ny. As a side effect, this would also help the computer to avoid printing unreadable columns of 8-digit numbers followed by an exponent.

Units of zeta

Well what *are* the units of zeta? A phone call to a nearby authority confirmed that the FT community is suspiciously silent on the matter. Clearly a name is required here also. My colleague proposed ***Tony***, and I heartily agreed, with international symbol **Ty**. Zeta historians will note that the symbol ζ was first proposed by Fleischer and Hart (1972), long before Hurford and Green (1983) firmly established the viability of zeta calibration and promoted its routine use. There is therefore a *prima facie* case for *Bobs* or *Harts*. *Greens* would be another possibility, but they would be confused with *Grays* by future generations of dating undergraduates. No doubt there will be much further debate during which someone may discover that Archimedes used ζ to calibrate the hydrothermal displacement in a domestic basin.

In the mean time let us try to work out what a Tony is. The modern fission track age equation is usually written as

$$t = \lambda_d^{-1} \log(1 + \lambda_d \zeta \rho_d g \rho_s/\rho_i)$$

where g is the geometry factor, taking the value 1/2 for the external detector method and 1 for the population method. Now t is a time and λ_d is a rate (reciprocal time) so that $\lambda_d t$ is dimensionless. Multiplying both sides of the equation by λ_d shows that the term inside the log() must therefore be dimensionless. Also ρ_s/ρ_i is dimensionless, as is the geometry factor g. Therefore $\lambda_d \zeta \rho_d$ must be dimensionless. But λ_d is reciprocal time and ρ_d is reciprocal area, so ζ must have the dimension of area $\times$ time (or L^2T, as we used to say). The *units* of zeta may therefore be taken to be "square centimeter years", or $cm^2 \times a$, which may also be written as $Ma \times cm^2/10^6$, or in other words Ma/Ny. Therefore a

Tony is a million years per Nancy, or (if this is easier to remember) one Nancy Tony equals one Ma.

While on the subject of the FTA equation and units, let us resolve to express ρ_d as 1.55125×10^{-4} Ma^{-1} instead of 1.55125×10^{-10} a^{-1} and ρ_d in Ny (millions of tracks per square cm). Then the age t will automatically be in Ma, which is what we want, and we need never worry again about whether or not we should have multiplied ρ_d by 10^6 or about writing decimal numbers like 0.0000000000155. Thus Kerry's ρ_d and ρ_d would be 1.55125×10^{-4} and 1.33 instead of 1.55125×10^{-10} and 1.33×10^6, respectively.

Real Age

Readers are invited to join the Campaign for Real Age, in which the fission track age equation is written with the factor ρ_i / ρ_s included, i.e. as

$$t = \lambda^{-1} \log(1 + \zeta \rho_d g (\rho_s/\rho_i) (\rho_i /\rho_s))$$

or, in the linearised version,

$$t \approx \zeta \rho_d g (\rho_s/\rho_i) (\rho_i /\rho_s)$$

where ρ_s and ρ_i are the equivalent isotropic lengths of spontaneous and induced tracks. This is natural, because ρ_s/ρ_i is a ratio of *areal* densities of intersections of tracks with a surface, whereas it is the ratio of *volume* densities of fissioned ^{238}U and ^{235}U atoms, N_s/N_i say, that might be regarded as the more fundamental quantity. The N's are related to the ρ's by the equations

$$\rho_s = 1/2 \, N_s \rho_s \quad \text{and} \quad \rho_i = g \, 1/2 \, N_i \rho_i$$

so that $g (\rho_s/\rho_i) (\rho_i /\rho_s) = N_s/N_i$ and the simple fission track age equation is really

$$t \approx \zeta \rho_d (\rho_s/\rho_i) .$$

Fleischer and Hart (1972) explicitly expressed ζ as a product of several factors, including the ratio of etching efficiencies of induced and spontaneous tracks and the ratio of their etchable ranges. So this real age equation effectively extracts the latter ratio from ζ. This formally changes the *meaning* of zeta, but not the units. With much relief I will leave it to others — such as Hurford (1988) or Van den haute *et al* (1998) — to discuss what zeta actually *is*.

Incidentally, I have noticed a recent practice of presenting papers at conferences *without* citing the age equation. Indeed I have even seen presentations containing no equation at all! My advice to the young tracker is to program the equation into your logo or header so that it is displayed at the top of each slide. Then you can safely ignore it and still maintain credibility. After all, at least we *have* an equation, and a more interesting one than most, so let us flaunt it!

What is a Tony worth

How should we *interpret* a measurement of one Ty? The obvious way is to put $\zeta = 1$ in the FTA equation, along with standard values of the other terms. A problem with a direct interpretation is that the value of the induced track density, ρ_i, depends on the neutron fluence used, which in turn is measured by the dosimeter track density, ρ_d, which in turn will depend on the standard glass used. The value is also specific to the mineral and to the analyst. Also, as noted above, the real FTA equation has another factor ρ_i/ρ_s inside the parentheses. So we assume that $\rho_s = \rho_i$, which will be appropriate for an age standard, but not for a sample that may have been annealed. Then the condition $g \rho_s/\rho_i = 1$ means that the concentrations of *fissioned* ^{238}U and ^{235}U atoms are the same, i.e. $N_s = N_i$. This is the natural condition, rather than $N_s = N_i$. Equally naturally we take $\rho_d = 1$ Ny. Then substituting all of these values in the FTA equation gives an age of $t = 1$ Ma. Thus we get the meaning of **one Tony**:

> **the number of square centimeter years required to produce an age of 1 Ma when dating an age standard with equal concentrations of fissioned ^{238}U and ^{235}U atoms and a dosimeter track density of one Nancy.**

Actually, the age you get is 0.99992 Ma, but 1 Ma is close enough for Geology.

Sources

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Another Improved Method of Mounting Apatite Grains For Fission Track Analysis

by Hisatoshi Ito

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Abstract

An improved method of mounting apatite grains is suggested in which an apatite mount is made using resin only. This method has several advantages: First, it is very simple to make. Second, almost all the grains are placed horizontally. Third, the mount is prepared as the same size of that of zircon. Fourth, the mount is very thin, ~1 mm. Fifth, if it is broken (though very rare), it is easily repaired. Sixth, because of the slight convex shape of the other side of the mounting plane, apatite and mica should attach firmly together during irradiation.

Introduction

In many fission track laboratories, apatite mounts are prepared by placing a blob of Petropoxy™ on a glass slide. In the previous issue of On Track, Asaf Raza reported an improved method of mounting apatite. In even Asaf's method, grains are mounted on a glass slide, which requires some skill and wastes glass slides! Here, I propose quite a different and very simple procedure.

Method

1) Making a Teflon-glass slide: Prepare a usual glass slide of 2.5 cm x 7.5 cm and PFA Teflon™ sheet of 0.5 mm thick. Cut the Teflon sheet of 3 cm x 5 cm. Attach double-sided adhesive tape on the glass slide and mark a square of 6 mm x 6 mm on the adhesive tape by Magic ink™. Then cover and attach the Teflon sheet to the glass slide as shown in Figure 1.

2) Making a Teflon mold: Prepare a mold of PFA Teflon sheet of 0.5 mm thick that makes the same size of zircon mount as shown in Figure 2.

3) Write a sample name on the glass part by Magic ink and spread a very fine film of Vaseline™ and pour a few milligrams of apatite grains on the Teflon side of the Teflon-glass slide.

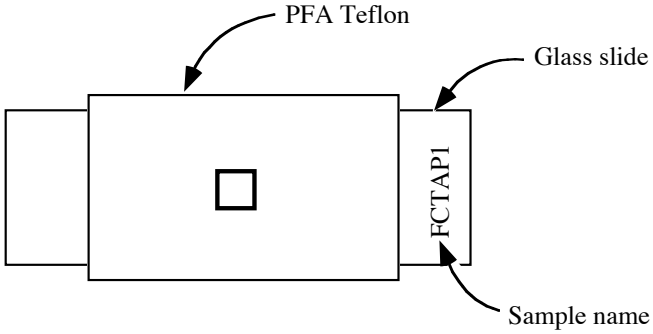

Figure 1. The Teflon-glass slide.

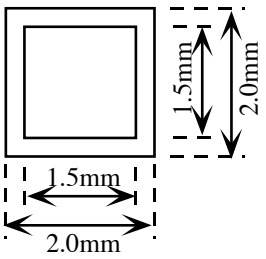

Figure 2. The Teflon mold.

4) Under a binocular microscope, evenly distribute the grains over the marked area with a fine pen wetted with ethanol.

5) Cover a hot-plate with aluminum foil and place the Teflon-glass slide on a hot-plate of ~125 °C. Put the Teflon mold on the Teflon-glass slide and pore Petropoxy into the mold so that it fills the mold. Beware that the resin should be put at once to the appropriate amount so as not to flow (or move) the apatite grains.

6) If the resin is thick, remove it little by little so that it comes to ~1 mm thick. Leave it for ~15 minutes so that the resin (apatite sheet) get hardened.

7) After cooling, write the sample name on the apatite sheet with a diamond pencil and remove the mold and apatite sheet from the Teflon-glass

slide and then remove the mold from the apatite sheet. Trim the edges of the mount by sand paper.

The principal advantages are that the apatite mount has the same size and shape of that of zircon (though a bit thicker), so both of them are treated as the same manner in irradiation. Even if it is broken by accident when gliding, it is easily repaired by adding more resin on the apatite sheet. Finally, since the mount has a slight convex shape because of the surface tension of the resin, hopefully (sorry, not yet confirmed) it should work so as to attach the grains and micas firmly when they are packed together.

Acknowledgment

Asaf Raza taught me how to make the apatite mount using a glass slide during my stay in Melbourne in 1993-94. His recent paper on the same subject greatly encouraged my motivation to write this short paper.

The Zeta-Potential of Apatite and Zircon: Its Significance for Mineral Separation

by Ewald Hejl

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Re-discovery of the Zeta-Meter

Six years ago, when I started to install a fission-track lab at the University of Salzburg, my mental zeta world was disturbed by the discovery of a Zeta-Meter in the cellar of our department. This apparatus was invented by RIDDICK in 1960, i.e. in the early days of fission-track discoveries, but I wonder if the inventor was conscious of that. The Zeta-Meter is composed of an electrophoresis cell, a timer, a voltmeter and a microscope (Fig. 1). Prof. Paul NEY purchased the apparatus from Zeta-Meter Inc., New York, in the late sixties. (Ed. note, Ewald kindly provided a reproduced copy of a photo of the apparatus, however it did not scan well enough to be reproduced again - therefore, copies can be acquired directly from the author)

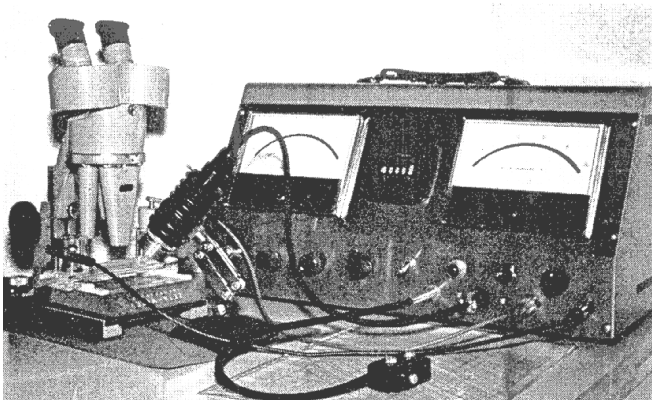

Figure 1. Zeta-Meter ready for action: the electrophoresis cell is situated under the objective of the microscope. Electric devices (voltmeter and microamperemeter) are on the right-hand side.

The zeta-potential is responsible for the electrokinetic properties of a solid phase in suspension. It corresponds to the electric tension at the phase boundary between the grains and the surrounding liquid. This tension can be measured with the Zeta-Meter by following procedure: A horizontal glass tube is filled with a suspension of fine mineral grains. Afterwards, a constant electric tension is applied to the ends of the tube. Depending on the sign of their charge, the grains will move either to the cathode or to the anode. The velocity of several grains is measured under the microscope, by recording the time that the grains need to move over a given distance. Zeta is calculated as follows:

$\zeta = 1.13 \cdot 10^5 (\eta/\varepsilon) (v/E)$
ζ = Zeta-potential (mV)
η = Viscosity of the liquid (poise)
ε = Dielectricity constant of the liquid
v = Mean velocity of the grains (μm/sec)
E = Electric field strength (Volt/cm)

NOTE: DO NOT INSERT THIS ZETA-VALUE INTO YOUR AGE EQUATION! EVEN AFTER CALIBRATION WITH DURANGO APATITE YOUR AGES WILL BE WRONG.

Zeta-Potentials of Apatite and Zircon

Several millions of tons of apatite are separated every year for the production of fertilizers by the chemical industry. This enormous quantity can not be provided by use of heavy liquids in funnels or constrictional tubes. In fact, apatite is mostly concentrated by chemical flotation.

Flotation chemicals change the surface properties of a specific mineral and should make it hydrophobic. When air is blown into a suspension, hydrophobic grains stick to ascending air bubbles and concentrate in a foam on the surface of the flotation cell (Fig. 2).

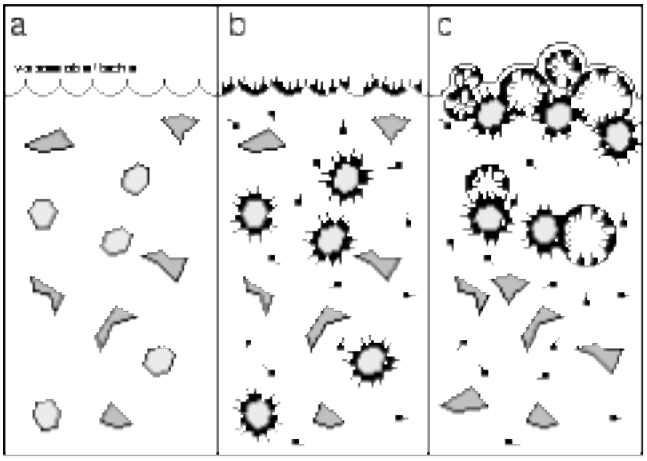

Fig.ure 1. The principle of chemical flotation: a: Mineral grains in suspension; b: Adsorption of flotation chemicals on the surface of specific minerals; c: Hydrophobic grains stick to ascending air bubbles and concentrate in a foam at the surface of the flotation cell.

Most flotation chemicals are weak acids, bases or the corresponding salts. The adsorption of their ions on a mineral surface is controlled by the electric tension of the mineral surface, i.e. by the zeta-potential, which is not constant and usually depends upon the pH of the suspending solution. NEY (1973) has measured pH dependent zeta-potentials for over 80 mineral species. Zircon has a positive zeta-potential over a wide range of pH values and consequently should be separated with anionic flotation chemicals. Apatite has a positive zeta-potential up to pH 3. Between pH 3 and 9, apatite has a very low zeta-potential between -10 and +10 mV.

We have used this information for the development of a laboratory flotation procedure allowing the separation of both apatite and zircon (cf. HEJL & NEY, 1994). This method is suitable for the sand fractions of crushed silicate rocks like granite or gneiss.

Practical instruction for the flotation of apatite and zircon

First you need a flotation apparatus. It is composed of a water tank, a stirring device (it is very similar to a kitchen mixer) and an air pump - that's all. Our flotation cell has a volume of two litres. The following proposal refers to that volume.

1) Break and sieve your sample under dry conditions. Avoid any contact with tap water.

2) Take a sieve fraction between 63 and 250 μm for further treatment. Wash it with distilled water until clay and silt particles are mostly removed.

3) Fill a large beaker with 2 litres of distilled water and add 5 ml of 10% H_2SO_4. After homogenization, the pH should be around 4.

4) Give 100 g of the washed sand fraction into the flotation cell and fill it up with the diluted solution of H_2SO_4.

5) Start the stirring device and wait for 10 minutes.

6) Add 2 ml of an aqueous solution (1%) of the flotation chemical ® HOE F 2874 (registered trade mark of Hoechst AG, Frankfurt am Main) and wait for 5 minutes.

7) Start the air pump and immediately add one small drop of ® Flotanol D 14 (registered trade mark). One minute later, remove the foam from the surface of your water tank which should contain the apatites and zircons.

8) Give the foam into a large funnel with a filter paper and wash it thoroughly with water.

9) Dry the filter paper and check the separated minerals under the microscope.

Do not worry about the costs. The indicated chemicals are very cheap. Send me an e-mail if you need more information. I have processed more than 100 samples by that method. Believe me: It works.

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SPECIAL ANNOUNCEMENT

2000 Fission Track Conference

The 9th International Conference on Fission Track Dating and Thermochronology will take place between 6-11 February, 2000 at Lorne, a coastal resort in the Otway Basin, about two hours drive from Melbourne. The conference is being co-convened by **Andy Gleadow** and **Barry Kohn**. The organising committee comprises all members of the La Trobe Thermochronology group, **Paul Green** (Geotrack International), **Dennis Arne** (University of Ballarat), **Geoff Laslett** (CSIRO) and **Peter Kamp** (University of Waikato).

A conference web site will soon be established and the first circular will be sent out in the next three months. An exciting programme is being planned - stay tuned for further announcements.

Short Tracks: News

As it comes time to finally pull this issue of On Track together, it seems that many FT'ers are once again finishing off major research projects as well as making tracks from one place to another.

As many of you probably know already, late last year **Tony Hurford** was suddenly diagnosed with a serious heart condition and disappeared from circulation for a bit. Subsequently, On Track received quite a few letters from Trackers asking if any news was available concerning Tony's health. Well, we are happy to report that Tony has responded to an approach for information, and that he is once again roaming the halls of UCL, and even "tracking" now and then. In order to keep the "embarrassment" level down, the information presented here has been heavily edited.

Basically, while leading a first-year field trip in October, Tony experienced some pain in the left arm and chest. This eventually led to heart surgery in late December, in the Middlesex Hospital in Central London. Fortunately, he was walking 24 hours after the operation and was discharged from hospital 4 days later on Boxing Day. Unfortunately, not only did he find the hospital food "dreadful", but he also had to miss the UCL Christmas party - especially disappointing since the booze for the party was supplied by Eurotrack (™?).

Tony wants everyone to know that he is making great progress, and that neither the surgeons nor the cardiology consultants want to see him again. He was also quick to point out that during his absence the lab was always in the capable hands of **Andy Carter**, **Kit Johnson**, and **Kerry Gallagher** (both now at Imperial College), **Dave Upton** and **Ruth Siddall**. Furthermore, he is undergoing (or has by now) a serious tracking training course from Andy Carter in order to once again bring him back up to snuff with the difficult job of counting tracks. Now that he has given up much of the Department Admin., Tony hopes that in the near future he will finally find some time to write those papers that have been sitting around for so long; including the Tardree Rhyolite (??) and the Irish Granites (this was probably singled out for the benefit of some - including the Editor). Finally, Tony wants everyone to know that he and his family greatly appreciate all the encouraging comments and cards received in response to the early news of his poor health.

On to other news, in a recent letter to the Editor, **Gerard Poupeau** was kind enough to send us some information concerning some of the exciting work, both in Archaeometry and Geology, being undertaken by the Groupe de Geophysique Nucleaire in Grenoble. He reports that in the first of these two fields, they are presently involved in obsidian provenience studies in the Near and Middle Orient, and along the Andean belt, with projects from Chile to Colombia. In the second, they are working mainly on continental margins in Brazil, Chile, Guyana, Mexico, Oman and around the Western Mediterranean basin, and on the tephrochronology of central Colombia. Programs are also ongoing in the Western Alps.

Gerard reports that many graduate students are involved in these programs. These include Ph.D. students **Olivier Dorighel** and **Ludovic Bellot-Gurlet** in Archaeometry, and **Stephane Schwartz** and **Bouchra Jakni** in Geology, as well as 3 Masters students in Geology (**Florence Bigot**, **Jerome Defaux**, **Fabienne Solacroup**). Two visiting Professors are also completing their Ph.D. research on FT dating in

Grenoble: **Gloria Toro**, from Medellin (Colombia), and **Ali Azdimousa**, from Oujda (Morocco). Other visiting scientists to Grenoble include: **Jose Antonio Cupertino**, from the Federal University in Porto Alegre/Petrobras (Brazil), Thierry Calmus UNAM, Hermosillo (Mexico) and Madjid Akkouche Sonatrach (Algeria).

Dave Coyle (remember him? - who could forget is more likely) recently wrote to bring us all up to date on his happenings. Seems he has well and truly left the tracking community and joined the "Dark Side" as a "hard-boiled international computer consultant" in the States. He tells us his job is great, but unfortunately, he's swamped. As he puts it, the job is a "big change from little-old (pun intended!) fission tracks! But at least at La Trobe, you don't get fingerprinted by the FBI and have to pee in a cup in order to get onto the computer network." He also says that we will all see him down in Australia at the 2000 FT conference (see advert somewhere in this issue), and that his talk will be prepared along the lines of reflections upon the academic way of doing things, seen through the eyes of that same "hard-boiled international consultant" (hmmmm???).

Ray Donelick of Donelick Analytical, Inc., wrote to inform us that **Margaret B. Donelick** (believe it or not, they are related) recently left Amoco Corporation after 6.5 years service to join Donelick Analytical, Inc. full-time. However, he would not give any indication as to when the rest of the family would be joining them as a voting partners of upper-level management.

Hot off the press is some news from **Annia Fayon**. As some might already know, she completed ("finished, defended, signed, sealed, delivered") her Ph.D. at Arizona State University last August, but sadly didn't get around to telling us until after the last issue had gone to press. Up until recently she has been working on papers and teaching part time at the community colleges around ASU, as she puts it - "trying to recover from the diss." However, she just wrote in to report that she recently started a post-doc at the University of Minnesota (see her new address in the directory), where she is working with **Donna Whitney** on the exhumation of rocks within the Central Anatolian crystalline complex, Turkey. She has enjoyed the move, and all is going well (Ed. note - just wait until she gets her first real Minnesota winter).

Hideki Iwano, from the Kyoto Fission-Track Co., Ltd., wrote to inform us that he has finished up his Ph.D. at the Kyushu University, entitled 'Study on the absolute age calibration for fission-track dating method' under the supervision of **Prof. Dr. Eiji Izawa** and **Dr. Koichiro Watanabe**. All the analytical work was performed at the laboratory of the KFT under the general guidance of **Tohru Danhara**, the President of KFT. He re-investigated the geometry factor for fission-track dating using the external detector method, involving the 238U decay-constant problem in the absolute age calibration. The main part of his thesis is published in "Advances in Fission-Track Geochronology" edited by P. Van den haute and F. De Corte.

Another member of the "Hey, I've finished my Ph.D. and am now making real money" group is **Carlos Alberto Tello Saenz**, from the Universidade Estadual de Campinas in Brazil (see directory). He finished his thesis, supervised by Prof. Dr **Julio Cesar Hadler Neto**, in June, 1998. He is now working on regional tectonics of the southeast Brazilian basement rocks, studying temporal location of low intensity and short duration thermal events, using apatite fission track analysis. This work is being done with the cooperation of Prof. Dr. **Peter Hackspacher** and Ph.D. student Luiz Felipe Ribeiro of the university UNESP-Rio Claro SP-Brazil.

Just after the last issue went out, On Track received a note from **Renato Pagliuca**, an Italian student who has recently earned a Ph.D. position at Pavia University (Italy) (see address in directory). He wrote to inform us that with the cooperation of **Prof. Istvan Dunkl** (Tubingen University) and **Prof. Gianni Zuffa** (Bologna University), he will be carrying out a project involving fission track analysis throughout the Northern Apennine basins. The aim of his work is focused on investigating the provenance of Tertiary clastic deposits and reconstructing the burial history of the associated tectonic units. (Ed. note - thanks Renato for the information, and welcome to the Tracking community).

Joining the La Trobe Fission Track Group is **Ursula Weber**, who recently commenced a Ph.D. project entitled "The thermotectonic evolution of the northern Precambrian shield area of Western Australia" at La Trobe University under the supervision of **Barry Kohn** and **Andy Gleadow**. Ursula completed her M.Sc studies at the University of Giessen, Germany, which also involved structural mapping, and microstructural and textural studies using newly developed scanning electron microscope techniques. Part of this work was carried out during a year long visit at the University of Liverpool where Ursula held a German Academic Exchange Service scholarship.

Finally, since the last issue of On Track went out, the Editor received a note from **Don Miller** (ex. RPI). Don wrote to inform us that since retiring, he has moved on to other interests, and to please remove him from the mailing list. In closing, he bids all his past tracking colleagues ado, and best wishes for the future.

Slightly Longer Tracks

Annealed Tracks- exhumed from the shear zone

by Mel Mitchel
ex. La Trobe University

It seems to be a tradition in many *On Track* articles to load up the puns and double entendres (ie. see any article by *Tracker*). So, as a former tracker who has undergone some recent fission, I would like to offer a different perspective and hopefully initiate some discussion regarding our PR work with other geoscientists. In particular, there is a well defined canyon separating many geomorphological interpretations and fission track thermochronology (the south eastern margin of Australia being a case in point). If one is brave enough to venture forth and actually discuss the raw nuts and bolts of both scientific methods of analysis, it is often found that little understanding is had between the two disciplines. Often, time intervals are not coincident or evidence is taken too literally.

The clearest understanding of these problems has come to me through discussions with geologists who work in similar geographic regions, but apply different methods. Acceptance or difficulty in understanding my FT results has led to only passing interest at best, and certainly no clear understanding of the ramifications of the results. FT analysis retains an air of mystery or uncertainty for many non-FT workers. I suggest that this is in part due to the difficulty geoscientists have with interpreting thermal history data that records a cumulative history rather than the more traditional notion of closure temperature. It seems that some FT ages were in the past taken as a date of cooling, which we know is only true in special cases of rapid cooling (eg. volcanics, rapid exhumation, etc.). So what was perhaps originally presented as an apatite FT age, was then used by others as a precise time of cooling below a closure temperature of ~110°C. Of course modelling tells us that this is a minimum estimate of the initial time of cooling. In this case, the track length distribution then provides the style of cooling below ~110°C.

So, it is important to point out that the FT method really only provides an estimate of the cooling pattern of a sample between 110 to 60°C (a select interval of temperature over which tracks are annealed), the shape of which is primarily defined by the track lengths. The FT age then provides the 'stretch'; the time interval over which tracks were annealed and simply distends or compresses the shape of the temperature cooling path (see Fig. 1).

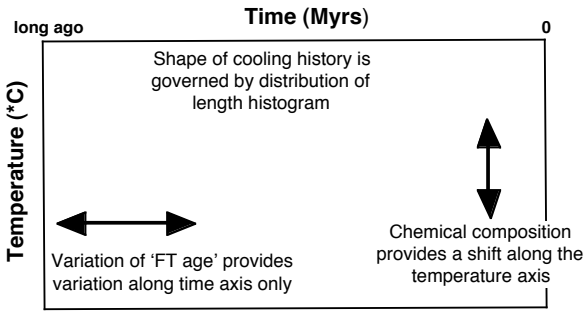

Fig.ure 1. The relationships between temperature, time, fission track age and chemical composition. Details discussed in text.

My point with all this detail is that most geoscientists do not know what to do with this information and are generally neither familiar with the patterns of FT parameters associated with various thermal histories, nor what they imply. The only familiar component is the term 'FT Age (Ma)'. This terminology (Ma) I would read as a specific estimate of a point in time. As described above, *FT Age* is more clearly described as a minimum estimate of the interval over which a sample was below a total annealing temperature.

Perhaps this 'Age' component may be represented more simply as a time unit such as Myrs, but I believe *Ma* is misleading and has caused much confusion. The term 'FT Dating' has not been widely used for many years, instead replaced by *thermochronology* or *analysis*. However, the initial concept of 'dating' and 'Ma' has remained.

Alternative names could be used such as interval or integral, but a great deal of publicity is needed to truly make the method the powerful tool it has the potential to be.

As for work with geomorphology, the lines below ~60°C on Monte Trax models in reality have no FT constraints, and for the most part I believe will accommodate the erosional information from surface geology. Clearly, flexible discussions, including the limitations and resolution problems with our time temperature models need to be instigated..

Recent Fission-Track Papers/Extended Abstracts

Please send items for listings in On Track to the editor. The reference or a photo copy of the first page will suffice but a copy of the entire paper is appreciated. We are also interested in non-fission-track papers that may be of special interest to the fission-track community. Papers in press are welcome, please include an estimate of the expected month of publication.

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Mercier de Lépinay B., Michaud F., Saint-Marc P., Calmus Th., Bourgois J., Poupeau G., et l'équipe NAUTIMATE : Bandy W., Castree M., Guerrero-Garcia J., Olu K., Sosson M., Villeneuve M. et Rinaldi C. (1997) Large Neogene subsidence event along the Mid-America trench off Mexico (18-19°N) : evidences from submersible observations, Geology, 25, 387-390.

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Ed. NOTE: As some will notice, not all items listed above would necessarily fit into the "recent" catagory, however, they have been listed at the request of the authors as a means to draw attention to them. Special thanks to Sandy Grist (Halifax), Peter Jensen (Denmark) and Gerard Poupeau (Grenoble), who sent lists of the (recent) publications from their labs. Peter was also kind enough to send reprints along with his list. This might seem a bit biased towards papers put out by particular groups, but this is due once again to the fact that few people/groups other than those noted above bothered to contribute listings of their recent or upcoming publications. Come on folks, we all know that there is a great deal of excellent work being done by the FT community, so please let other Trackers know. The Editor should not have to do all the searching needed to find out what has been published. On Track needs much more participation from all trackers if it is going to survive.

Call for Contributions to the December 1998 On Track issue 17

The next issue of On Track is scheduled for release in December, 1998 and we are already looking for contributions. On Track welcomes contributions of virtually any kind, including news and gossip, job openings, descriptions of new lab techniques, reviews of useful products, raving editorials about what all the other labs are doing wrong, meeting announcements, cartoons, and descriptions of what you are doing in your research.

If you would like to contribute, **PLEASE** send the final text no later than December 1, 1998 (DEADLINE). If you propose to submit a substantial article, **PLEASE** let the editor know ASAP. We have recently been holding up the publication of issues due to late articles, but this practice needs to stop.

On Track includes a list of recent and forthcoming Fission Track papers. If you know of a paper that was published recently or that is in press and should appear in the near future, please let us know so that it can be added to the list. Also, if you happen to move locations (or know of someone who has moved) due to a change in jobs or finally finishing off the thesis and graduating, please inform us.

On Track is also happy to run Advertisements. Please contact the editor for advertising rates - they are typically adjustable, and usually depend on the number submitted, and the expected mailing costs incurred by the editor. To date On Track has remained free of charge and will continue to do so (at least for the near future). However, to save costs we generally mail only one copy per lab so please be sure to photocopy the lab copy and pass copies around your lab. If possible, we will also send out On Track electronically, so please make sure the editor has an up-to-date e-mail address for each person/lab.

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1998 UPDATE OF THE INTERNATIONAL FISSION-TRACK DIRECTORY

This directory is published solely for the information of fission-track researchers. It is neither a comprehensive directory including all fission-track researchers nor an official document endorsing the scientific stand of individuals by the fission-track community. We provide here an update with the hope that we have accounted for the changes in addresses that have occurred since the last release of the directory. ***If you have changed your address, know someone else who has or think that someone should be on this list, please let the new Editor know (agrist@is.dal.ca).***

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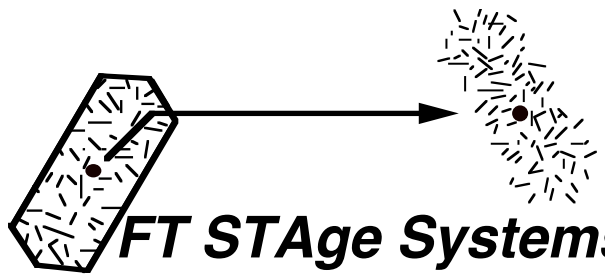

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An early version of the system is described in a paper in Nuclear Tracks and Radiation Measurements, vol. 21, p. 575-580, Oct. 1993 (proceedings issue for the 1992 Workshop on Fission Track Thermochronology held in Philadelphia).

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